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(71) Applicant: FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E. V. [DE/DE]; Leonardstrasse 54, D-80636 Munich (DE)

(72) Inventors: NÄGELE, Helmut, Gewerbestrasse 18, D-76327 Pfinztal (DE); EISENREICH, Norbert; Von den Werren 10, D-76327 Pfinztal (DE)

(74) Agent: ISENBRUCK, Günter, Bardehle, Pagenberg, Dorst, Altenburg, Geissler, Isenbruck, Theodor-Heuss-Anlage 12, D-68165 Mannheim (DE)

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(54) Title: FLAMEPROOFING AND FUNGICIDE AGENTS WHICH ARE BIOLOGICALLY SUITABLE FOR USE IN CONSTRUCTION, FOR INSULATING MATERIALS CONSISTING OF RENEWABLE RAW MATERIALS

(57) Abstract
The invention relates to a method for flameproofing insulating materials made with renewable raw materials. According to this method, the insulating material is impregnated with an aqueous impregnating solution containing 5 to 20 wt, % sodium and/or potassium carbonate as the flameproofing and fungicide agent and additionally, 2 to 10 wt.% of a tenside as a fungicide. The insulating materials are shavings of hemp, miscanthus, flax, jute and ramie and insulating matting consisting of fibers of hemp, miscanthus, flax, ramie and shorn wool.



Translation

# Flameproofing and fungicide agents which are biologically suitable for use in construction for insulating materials consisting of renewable raw materials

The invention relates to a method for flameproofing and protecting insulating material made of renewable raw materials against fungus, the use of an impregnating solution for flame-proofing and protecting insulating materials made of renewable raw materials against fungus as well as flame-proofed insulating material made of renewable raw materials that is also protected against fungus.

Over the past few years there has been a clear trend towards ecologically oriented construction which is characterized by an increase in use of wood and derived timber products. The reason for this is that the public has been sensitized to ecological issues and the associated orientation towards products made of renewable raw materials. This is the background, for example, for efforts to replace mineral fibers used for sound and heat-insulating purposes in construction with insulating materials made of natural, renewable raw materials. Insulating materials on the basis of renewable raw materials, for example, today are shavings of the hemp plant that are used as loose bottoming for floors and that act as sound and heat insulation.

Construction materials made of renewable raw materials such as wood or insulating material on the basis of cellulose fibers are susceptible to microorganisms such as bacteria and fungus. In addition, such materials, if they are used untreated, are flammable and can increase the risk of fire. Treating such construction materials with flameproofing and fungicide agents therefore is

Patent US 4,780,341 discloses sodium carbonate as a wood preservative with flame-inhibiting and anti-fungal effect. It does not mention its use as an impregnating agent for plant shavings or fibers.

Patent DE-A 38 17 859 discloses carbonate solutions as a flameproofing agent for construction wood and timber for mining.

According to DE-A 862 666 a solution that contains carbonate and a soap forming mixture of synthetic fatty acids is used as a flameproofing agent for wood and cellulose-containing building boards.

According to DE 9252 aqueous carbonate solutions are used as a flameproofing agent for wood chips and plant fibers.

The object of the invention is to provide a flameproofing agent for flameproofing insulating materials consisting of renewable raw materials that meets the requirements of ecological construction standards. The object of the invention further is to provide this agent in conjunction with a fungicide that is biologically harmless. The flameproofing and fungicide agents are to be inexpensive, easy to process and should be suitable for use in construction and not have a negative influence on the insulating materials with regard to their construction properties.

The object of the invention is attained through a process for flameproofing and protecting insulating material consisting of renewable raw materials against fungus in which the insulating material is impregnated with an aqueous impregnating solution containing 5 to 20 wt.% sodium and/or potassium carbonate as the flameproofing and fungicide agent and additionally 2 to 10 wt. % of a tenside as a fungicide, characterized in that the insulating materials are shavings of hemp, miscanthus, flax, jute and ramie as well as insulating matting consisting of fibers of hemp, miscanthus, flax, ramie and shorn wool.

All information pertaining to concentration refers to sodium or potassium carbonate that is free of water of crystallization.

Insulating material consisting of renewable raw materials are natural fibers (bast fibers) obtained from fibrous plants such as hemp, flax, miscanthus (Chinese reed), furthermore shorn wool as well as construction textiles made of them such as fleece, felt, material and wadding. Insulating material consisting of renewable raw materials above all are plant stems (natural shavings) such as the shavings of hemp, miscanthus, flax, jute and ramie.

Preferred insulating materials that are impregnated with the aqueous impregnating solutions according to the invention are the listed natural shavings, especially shavings of hemp plants, which, for example, are used as loose bottoming in floors or partitioning walls, as well as insulting matting made of natural fibers such as matted insulating matting, above all insulating matting made of hemp, flax, miscanthus, ramie and shaved wool fibers.

The impregnating solutions that are used for the method in accordance with the invention contain 5 to 20 wt.% sodium and/or potassium carbonate as flameproofing agent. Preferably the aqueous impregnating solutions contain 15 to 20 wt. %, especially preferred 18 to 20 wt. % sodium or potassium carbonate. The flameproofing effect of sodium and potassium carbonate in the flameproofing impregnating applications according to the invention probably is due to the disintegration of the carbonate in the heat generated by the fire while releasing $CO_2$, which has extinguishing properties.

The subject of the invention also is the use of sodium or potassium carbonate for flameproofing and protecting insulting material consisting of renewable raw materials against fungus. The subject of the invention above all is the use of an aqueous impregnating solution that contains 5 to 20 wt. %, preferably 15 to 20 wt. %, especially preferred 18 to 20 wt. % sodium or

potassium carbonate as flameproofing and fungicide agent for the above insulating material consisting of renewable raw materials.

The impregnating solutions used in the method according to the invention can contain an additional fungicide agent. In principle any fungicide agent with fungistatic or fungicide effects can be used that are ecologically and biologically suitable for use in construction and that are soluble in aqueous impregnating solution. Suitable, ecologically and biologically suitable for use in construction fungicide agents are tensides such as soaps or synthetic detergents. In general the aqueous impregnating solutions contain 2 to 10 wt. %, preferably 5 to 10 wt. %, especially preferred 5 to 8 wt.% of a tenside as a fungicide agent. Suitable tensides are anionic tensides such as alkylbenzenesulfonate, alkane sulfonate, fatty alcohol sulfate, fatty alcohol ether sulfate, alpha-olefin sulfonate, alpha-ester-sulfonate, alkyl phosphate, and alkyl ether phosphate, non-ionic tensides such as fatty alcohol ethoxylate, alkyl phenol ethoxylate, fatty amine ethoxylte, fatty acid ethoxylate, fatty acid ester ethoxylate, alkanolamide, sugar tensides and aminoxide, cationic tensides such as quaternary ammonium salts and imidazolinium compounds, especially alkyl ammonium compounds and amphoteric tensides such as betaine and sulphonic betaine. Preferred tensides are those with characteristic microbiostatic and microbiocide effects, especially soaps such as sodium palmitate and sodium stearate, curd soap, cationic tensides such as quaternary ammonium salts, especially those with short alkyl chains such as dodecyl-, dimethyl-, benzyl ammonium chloride and amphoteric tensides such as 7-$C_{10}$-$C_{16}$-alkyl-3,7-diazaheptane acids. Especially preferred tensides are 7-$C_{10}$-$C_{16}$-alkyl-3,7-diazaheptane acids and curd soap.

The effect of the tensides as fungicide agent probably is due to the fact that the tensides attach to the cellulose limit layers of the fungus as surface-active agents which destroy the semi-permeability of the cytoplasm membranes that are mostly made of lipids and proteins. This prevents metabolism and thus the growth of the fungus in a physical manner.

The construction materials can be impregnated with the aqueous impregnating solutions according to the invention using all customary methods, for example painting, spraying or saturating.

The aqueous impregnating solutions according to the invention can also be used as wood preservation paint. Preferably such an impregnating solution that is used as a wood preservative contains 10 to 20 wt. % sodium and/or potassium carbonate and 2 to 10 wt. % tenside. For an effective flameproofing protection a light concentration of sodium or potassium carbonate on the surface of the wood suffices. It preferably is 20 to 40 $g/m^2$ of the surface of the wood. The tenside quantity preferably is 5 to 15 $g/m^2$ of the surface of the wood. The use of the aqueous impregnating solution in accordance with the invention as a protective coat for wood is suitable for wood parts that do not come in contact with water. Otherwise it is possible that protective coats are washed off. This means such protective coats are especially suitable for protecting wood that is used inside.

Preferably the aqueous impregnating solutions in accordance with the invention are used for flameproofing and protecting the above insulting materials against fungus. Such flameproof insulating materials in general contain 2 to 10 wt.%, preferably 2 to 5 wt. % sodium and/or potassium carbonate as flameproofing agent. Insulating materials that also have a fungicide agent in general also contain 0.5 to 3 wt. %, preferably 1 to 2 wt. % tenside as a fungicide agent. The insulating materials preferably are impregnated with the impregnating solution through spraying or dipping. This can be done, for example, by spraying the insulating materials in a rotary dryer and subsequent drying.

Especially preferred, the aqueous impregnating solutions that are used in accordance with the invention are used for flameproofing and protecting plant shavings, especially shavings of the hemp plant, against fungus.

This means it now is possible to discontinue the use of the customary protective layer of bitumen which is not considered biologically suitable for use in construction. By not using the protective layer of bitumen, the heat insulating properties of the plant shaving insulating bottoming is improved.

The flame-proofing and fungicide agents used in accordance with the invention are not toxic to humans. In addition, there is no danger that toxins are released in a fire due to the flameproofing materials used that could get into the atmosphere or into the ground together with the water used for extinguishing the fire. The fungicide agents used in accordance with the invention are biologically suitable, even with regard to subsequent disposal of the building materials. Furthermore the aqueous impregnating solution used in accordance with the invention provides an inexpensive alternative to customary products.

The invention is described in more detail in the following examples.

**Examples**

**Fire Tests**

**Examples 1 through 8**

An aqueous $Na_2Co_3$ concentrate soda solution (approx. 200 g/l) that was saturated up to the solubility limit were sprayed (example 1: by dipping) in the quantities indicated in Table 1 (in l/kg hemp shavings) onto the shavings and the shavings then dried in order to provide the hemp shavings with a flameproofing impregnation layer. The shavings that were treated in this manner were tested for their behavior in fire according to DIN 4102 Part 1. In order to bring the shavings in to a shape that corresponds to the DIN [German Industrial Standard], the shavings were arranged in wire baskets so that a layer with a thickness of 10 mm and the corresponding dimensions pursuant to the DIN were obtained. Mesh width and thickness of the wire of the wire baskets were such

that the fire could develop and were 3.15 mm or 0.55 mm respectively. Initial testing of the wire basket showed that the burner flame was unimpeded and could penetrate the wire mesh. In all tested samples the flame front on the test object that was suspended in a vertical manner occurred after a flame exposure of 15 s and no more than 150 mm. Strong smoke development was detected in samples 7 and 8 only. This means all samples met the requirements of standard flammable construction material of building material class B2 according to the DIN. Furthermore it was found that the flameproof samples suppressed a smoldering fire following exposure to the flame. Untreated shavings showed a marked smoldering fire behavior, combined with very strong smoke development.

**Tests concerning fungal attack**

**Examples 1 through 13**

The tests concerning the fungicide effect of the flameproofing or fungicide agents used were conducted in accordance with DIN IEC 68. A mix culture of seven different fungus types with a starting concentration of $10^{[illegible]}$ fungus spores per ml suspension was applied to treated and untreated hemp shavings. After a breeding period of 28 days the mildew fungus growth was evaluated visually and divided into classes 0 trough 3 according to DIN. The classes are:

Class 0: No mildew fungus growth with 50-fold magnification detected.

Class 1: Mildew fungus growth is not or barely visible with the naked eye, but is clearly visible with a magnifying glass.

Class 2: Mildew fungus growth is clearly visible with the naked eye but only covers less than 25% of the surface of the test sample.

Class 3: Mildew fungus growth is clearly visible and covers more than 25% of the surface of the test sample.

The results are summarized in Table 1.

| Example no. | Spray quantity Soda solution in l/kg | Detergents ** | Fungal attack |
|---|---|---|---|
| 1 | 5.8 | - | 1 |
| 2 | 5.0 | - | 0 |
| 3 | 2.5 | - | 0 |
| 4 | 1.0 | - | 0 |
| 5 | 0.5 | - | 3 |
| 6 | 0.3 | - | 3 |
| 7 | 0.2 | - | 3 |
| 8 | 0.1 | - | 3 |
| 9 | - | Alkylbenzenesulfonate | 2 |
| 10 | - | Ampholytic surface active agent TEGO 2000 | 2 |
| 11 | - | Benzylidene conium chloride | 2 |
| 12 | - | [illegible] ammonium chloride | 2 |
| 13 | - | - | 3 |

* applied by dipping

** spray quantity 1.5 wt.% based on the weight of the shavings.

## Claims

1. Method for flameproofing and protecting insulating material made of renewable raw materials against fungus in which the insulating material is impregnated with an aqueous impregnating solution containing 5 to 20 wt.% sodium and/or potassium carbonate as the flameproofing and fungicide agent and additionally 2 to 10 wt. % of a tenside as a fungicide, characterized in that the insulating materials are shavings of hemp, miscanthus, flax, jute and ramie as well as insulating matting made of fibers of hemp, miscanthus, flax, ramie and shorn wool.

2. Method according to claim 1 characterized in that the tenside is curd soap or one or several 7-($C_{10}$-$C_{16}$-alkyl)-3,7-diazaheptane acids.

3. Use of an aqueous impregnating solution containing 5 to 20 wt.% sodium and/or potassium carbonate as the flameproofing and fungicide agent for flameproofing and protecting insulating material consisting of renewable raw materials against fungus characterized in that the insulating materials are shavings of hemp, miscanthus, flax, jute and ramie as well as insulating matting made of fibers of hemp, miscanthus, flax, ramie and shorn wool.

4. Use according to claim 3 characterized in that the aqueous impregnating solution additionally contains 2 to 10 wt. % of a tenside as a fungicide agent.

5. Flameproof insulating material consisting of renewable raw materials with fungus protection containing 2 to 10 wt. % sodium and/or potassium carbonate as flameproofing and fungicide agent and additionally 2 to 10 wt. % of a tenside as a fungicide characterized in that the insulating materials consist of shavings of

hemp, miscanthus, flax, jute and ramie as well as insulating matting made of fibers of hemp, miscanthus, flax, ramie and shorn wool.